

Contact Person:

Name: Sullivan, Kevin
Organization: NOAA/AOML CIMAS
Address: 4301 Rickenbacker Causeway, Miami, FL 33149
Phone: (305) 361-4382
Email: kevin.sullivan@noaa.gov

Investigator(s):

Name: Wanninkhof, Rik
Organization: NOAA/Atlantic Oceanographic & Meteorological Laboratory
Address: 4301 Rickenbacker Causeway, Miami FL, 33149
Phone: 305-361-4379
Email: Rik.Wanninkhof@noaa.gov

Name: Pierrot, Denis
Organization: NOAA/Atlantic Oceanographic & Meteorological Laboratory
Address: 4301 Rickenbacker Causeway, Miami FL, 33149
Phone: 305-361-4441
Email: Denis.Pierrot@noaa.gov

Dataset Information:

Funding_Info: NOAA Climate Program Office
Initial_Submission: 20161215
Revised_Submission: 20161215

Cruise Information:

Experiment Name: I08S
Experiment Type: Research Cruise
Platform Type: Ship
CO2 Instrument Type: Equilibrator-IR or CRDS or GC
Cruise ID: 33RR20160208
Cruise Info: AOML_SOOP_CO2; RR1603, I08S A.McDonald (WHOI) chief scientist
Geographical Region:
Westernmost Longitude: 76.4
Easternmost Longitude: 115.6
Northernmost Latitude: -28.3
Southernmost Latitude: -66.7
Cruise Dates (YYYYMMDD)
Start_Date: 20160208
End_Date: 20160315
Ports of Call:
Fremantle, Australia
Vessel Name: Roger Revelle
Vessel ID: 33RR
Vessel Owner: U.S. Navy; operated by Scripps Institute of Oceanography

Variables Information:

Variable Name: xCO2_EQU_ppm

Description of Variable: Mole fraction of CO₂ in the equilibrator headspace (dry) at equilibrator temperature (ppm)
Unit of Variable: ppm
Variable Name: xCO₂_ATM_ppm
Description of Variable: Mole fraction of CO₂ measured in dry outside air (ppm)
Unit of Variable: ppm
Variable Name: xCO₂_ATM_interpolated_ppm
Description of Variable: Mole fraction of CO₂ in outside air associated with each water analysis. These values are interpolated between the bracketing averaged good xCO₂_ATM analyses (ppm)
Unit of Variable: ppm
Variable Name: PRES_EQU_hPa
Description of Variable: Barometric pressure in the equilibrator headspace (hPa)
Unit of Variable: hPa
Variable Name: PRES_ATM@SSP_hPa
Description of Variable: Barometric pressure measured outside, corrected to sea level (hPa)
Unit of Variable: hPa
Variable Name: TEMP_EQU_C
Description of Variable: Water temperature in equilibrator (°C)
Unit of Variable: Degree C
Variable Name: SST_C
Description of Variable: Sea surface temperature (°C)
Unit of Variable: Degree C
Variable Name: SAL_permil
Description of Variable: Sea surface salinity on Practical Salinity Scale (o/oo)
Unit of Variable: ppt
Variable Name: fCO₂_SW@SST_uatm
Description of Variable: Fugacity of CO₂ in sea water at SST and 100% humidity (μatm)
Unit of Variable: μatm
Variable Name: fCO₂_ATM_interpolated_uatm
Description of Variable: Fugacity of CO₂ in air corresponding to the interpolated xCO₂ at SST and 100% humidity (μatm)
Unit of Variable: μatm
Variable Name: dfCO₂_uatm
Description of Variable: Sea water fCO₂ minus interpolated air fCO₂ (μatm)
Unit of Variable: μatm
Variable Name: WOCE_QC_FLAG
Description of Variable: Quality control flag for fCO₂ values (2=good, 3=questionable)
Unit of Variable: None
Variable Name: QC_SUBFLAG
Description of Variable: Quality control subflag for fCO₂ values, provides explanation when QC flag=3
Unit of Variable: None

Method Description:

Equilibrator Design:

Depth of Seawater Intake: 5 meters

Location of Seawater Intake: Bow, or engine room sea chest (mid ship)

Equilibrator Type: Spray head above dynamic pool with thermal jacket

Equilibrator Volume: 0.95 L (0.4 L water, 0.55 L headspace)

Water Flow Rate: 1.3 - 2.5 L/min

Headspace Gas Flow Rate: 70 - 150 ml/min

Vented: Yes

Drying Method for CO₂ in Water:

Gas stream passes through a thermoelectric condenser (~5 °C) and then through a Perma Pure (Nafion) dryer before reaching the analyzer (90% dry).

Additional Information: Primary equilibrator is vented through a secondary equilibrator.

CO₂ in Marine Air:

Measurement: Yes, 5 readings in a group every 4.5 hours

Location and Height: Bow mast, ~18 meters above sea surface

Drying Method:

Gas stream passes through a thermoelectric condenser (~5 °C) and then through a Perma Pure (Nafion) dryer before reaching the analyzer (90% dry).

CO₂ Sensor:

Measurement Method: IR

Manufacturer: LI-COR

Model: 6262

Frequency: Every 140 seconds, except during calibration

Resolution Water: $\pm 0.01 \mu\text{atm}$ in fCO₂_SW

Uncertainty Water: $\pm 2 \mu\text{atm}$ in fCO₂_SW

Resolution Air: $\pm 0.01 \mu\text{atm}$ in fCO₂_ATM

Uncertainty Air: $\pm 0.5 \mu\text{atm}$ in fCO₂_ATM

Manufacturer of Calibration Gas:

Std 1: JA02280, 233.46 ppm, owned by AOML, used every ~4.5 hours. Std 2: JA02264, 326.18 ppm, owned by AOML, used every ~4.5 hours. Std 3: JA02285, 406.06 ppm, owned by AOML, used every ~4.5 hours. Std 4: JA02646, 463.00 ppm, owned by AOML, used every ~4.5 hours. Std 5: 0.00 ppm, owned by AOML, used every ~23.5 hours.

Number of Non Zero Gas Standards: 4

CO₂ Sensor Calibration:

The analyzer is calibrated every 4.5 hours with field standards that in turn were calibrated with primary standards that are directly traceable to the WMO scale. The zero gas is ultra-high purity air.

Other Comments:

Instrument is located in the air-conditioned Hydro Laboratory. Ultra-High Purity air (0.0 ppm CO₂) and the high standard gas are used to zero and span the LI-COR analyzer.

Method References:

Pierrot, D., C. Neil, K. Sullivan, R. Castle, R. Wanninkhof, H. Lueger, T. Johannessen, A. Olsen, R. A. Feely, and C. E. Cosca (2009), Recommendations for autonomous underway pCO₂ measuring systems and data reduction routines, Deep-Sea Res II, 56, 512-522.

Details Co₂ Sensing:

details of CO₂ sensing (not required)

Measured Co₂ Params:

xco₂(dry)

Sea Surface Temperature:

Location: Hydro Lab

Manufacturer: Seabird

Model: 45

Accuracy Degrees Celsius: 0.002

Precision Degrees Celsius: 0.0002

Calibration: Factory calibration

Comments: Manufacturer's Typical Stability is taken as Precision; Maintained by ship. A regression fit between the average temperature measured in the Hydro Lab and the CTD surface temperature was done for all casts to estimate the SST. See additional comments below and supplemental ReadMe file.

Equilibrator Temperature:

Location: Inserted into equilibrator ~5 cm below water level

Manufacturer: Hart

Model: 1523

Accuracy Degrees Celsius: 0.015

Precision Degrees Celsius: 0.001

Calibration: Factory calibration

Comments: Resolution is taken as Precision.

Equilibrator Pressure:

Location: Attached to equilibrator headspace. The differential pressure reading from Setra 239, which is attached to the equilibrator headspace, is added to the pressure reading from the LICOR analyzer, which is measured by an external Setra 270 connected to the exit of the analyzer.

Manufacturer: Setra

Model: 270

Accuracy hPa: 0.15

Precision hPa: 0.015

Calibration: Factory calibration

Comments:

Manufacturer's Resolution is taken as Precision.

Atmospheric Pressure:

Location: On MET mast, ~17 m above the sea surface water

Manufacturer: RMYoung

Model: 61302V

Accuracy: ± 0.3 hPa

Precision: 0.01 hPa

Calibration: Factory calibration

Normalized: yes

Comments: Manufacturer's Resolution is taken as Precision; Maintained by ship.

Sea Surface Salinity:

Location: In Hydro lab, near CO2 system

Manufacturer: Seabird

Model: SBE 45

Accuracy: ± 0.005 o/oo

Precision: 0.0002 o/oo

Calibration: Factory calibration

Comments: Manufacturer's Resolution is taken as Precision; Maintained by ship. A regression fit between the average salinity measured in the Hydro Lab and the CTD surface salinity was done for all casts to adjust the SSS. See additional comments below and supplemental ReadMe file.

Additional Information:

The analytical system performed well throughout this cruise. Values for the ship's sensors were appended to the CO2 data record in real-time. Missing real-time values were taken from the MET files logged by the ship. Because of time-sync issues with the MET computer, the merging of CO2 and MET data was based on position for the first six days and then based on time for the rest of the cruise. After merging, there remained 584 analyses without atmospheric pressure nor salinity values. Missing atmospheric pressures were estimated by subtracting 0.11 mbar from the LICOR pressures. Missing salinity values were interpolated from surrounding good data and were flagged as 3. The temperature and salinity data from the CTD casts were used to estimate SSTemperature and to adjust the SSSalinity used in the fCO2 processing. A regression fit between the average temperature measured in the Hydro Lab (HLT) and the CTD surface temperature was done for all casts. After eliminating six outlying data, the resulting second degree polynomial equation was used to estimate the SST. $SST(\text{estimated}) = 0.002753 \cdot HLT^2 + 0.948538 \cdot HLT - 0.439656$; standard deviation of the differences between the CTD temperatures and the SST(estimated) is ± 0.158 degree Celcius. A regression fit between the average salinity measured in the Hydro Lab (HLS) and the CTD surface salinity was done for all casts. After eliminating one outlying datum, the resulting linear equation was used to adjust the SSS. $SSS(\text{adjusted}) = 1.000346 \cdot HLS + 0.006326$; standard deviation of the differences between the CTD salinities and the SSS(adjusted) is ± 0.0082 psu. See supplemental ReadMe file.

Preliminary Quality Control:

NA

Form Type:

underway